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Applying Learning Factory in Lean Management: The Experience of Undergraduate Students in a Malaysian Public University

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ABSTRACT

Employee's competency plays an important role in the organization sustainability. This is important as the business environment is facing globalization effect and changing customer's demand. However, there is a mismatched between workforce qualification and the changes in the business world. Therefore, universities play a big role in preparing students for the job market. The Faculty of Industrial Management, Universiti Malaysia Pahang has setup a learning factory in 2016 and embed it into the curriculum from October 2017 onwards. This research employed qualitative research in its data collection analysis. The experience of 56, second year undergraduate students who have used the learning factory in the Lean Management were reported. The result from this research reveal that learning factory help students to be exposed to real-life industry, improve student's understanding, gain practical experience, ability to relate theory with practical experience, learn new knowledge, make learning experience more interesting, and help to adapt to industrial life
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Keywords: Lean, Sustainability, Learning Factory, Qualitative study, TVET.

INTRODUCTION

Lack of skilled and qualified employees to work in the industry are among the challenges faced by industry during this globalization era. Furthermore, shorter product lifecycle, increase product variants and more intensify job rotation has increased the needs for companies to increase competency building. This new shift requires the need to improve both the education content and the didactical approaches in order to meet the new challenges in the manufacturing industry.

Employers are seeking graduates that possess a wide variety of skills apart from those directly associated with their area of studies. However, the current teaching and training methods used is lacking a continuous delivery of competencies especially in the manufacturing education (Tether, Mina, Consoli, & Gagliardi, 2005). Many of the higher learning education institutions are still using the traditional classroom method such as pictures, videos and case study to teach students about the manufacturing environment (Cachay, Wennemer, Abele, & Tenberg, 2012). Finding universal ways to effectively train these future employees to work in the industry is the key to prepare market ready workforce to work in the industry. One way is through the application of the learning factory concept that emphasis on developing student's competencies through hands on learning experience.

Realizing the importance of having hands on training embedded into the teaching and learning process, the faculty of Industrial Management, Universiti Malaysia Pahang has introduced the use of a learning factory into its curriculum with effect from October 2017. The project to build the learning factory has started from 2016. A Supply Chain learning factory facility was built and ready for use in September 2017 and was named "FIM learning factory". This paper is going to introduce the concept of the learning factory in the Faculty of Industrial Management, Universiti Malaysia Pahang. In addition, this study will also investigate the learning experience of students who have used the learning factory in the lean management course.

LITERATURE REVIEW

The Faculty of Industrial Management Learning Factory

The initial size of the learning factory is 588 square meter which is located in block T of the UMP Gambang campus. The learning factory comprise of a warehouse, a hand dryer manual operated assembly line, inspection processes, packaging processes, and a small fabrication workshop. This is to create a business environment where the young students will be able to know, experience and solve a real life problem in a small manufacturing setup. The flexibility, changeability and reconfigurable that characterized the learning factory will allows the students to reconfigure the assembly process based on a task assigned such as continuous improvement and optimization study. To expose the students with the concept of flexible production, changeable, cellular system, and reconfigurable production system, the learning factory was equipped with the following system: A changeable workstation using highly flexible plug-in system of tabular standard aluminium profile frames which can be easily mounted or knocked down, thus, allowing changeability. In addition, a flexible overhead wiring system has been installed to allow the wiring system to be easilly installed or removed when needed and a cellular production system to allow the assembly process to take place. Figure 1 shows various equipment installed in the learning factory

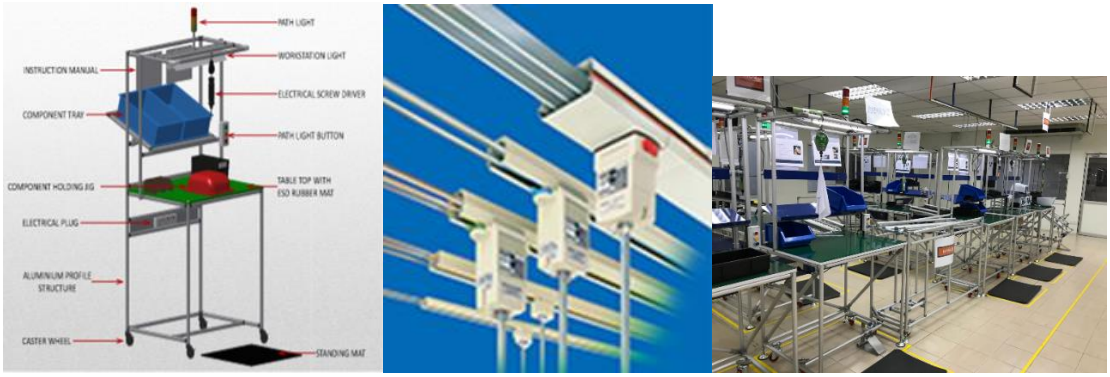

Figure 1: Various Equipment Installed in the FIM Learning Factory

To help the students with the design, the faculty has provided the students with the solid work software to allow product development using 2D and 3D drawings models. Three units of 3D printers as shown in figure 2 were available to enable the students to produce product realization based on the design made using the solid work software.

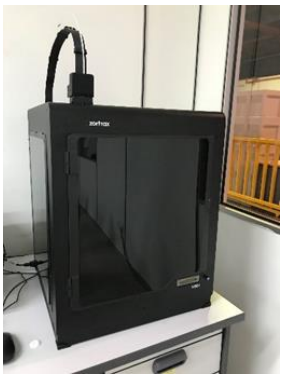

Figure 2: 3D Printer

A pilot study on the learning factory facility has been conducted from October 2017 and lean management subject has been chosen to be used in the learning factory. To illustrate the one-piece flow concepts, the workstations were arranged in a linear way next to one another with the sub-assembly process connected directly to the main assembly line. The learning factory flow allows the students to experience the whole supply chain process from parts receiving process until finish goods warehouse. The following pictures illustrate the set-up of the assembly line and fabrication workshop as shown in figure 3.

Figure 3: The Set-up of the Assembly Line and Fabrication Workshop

The FIM learning factory has received international recognition after being accepted as a member of the International Association of Learning Factory (IALF) during the Genaral Assembly of the IALF in Braunschweig, Germany.

Learning Factory Concept

The Learning Factory (LF) concept was first mentioned through the initiative of a group of universities from the United States in 1995 and was later adopted by European government for the education of engineers (Baena, Guarin, Mora, Sauza, & Retat, 2017).

Learning factory replicate a section of the value chain industry where various types of learning process, formal or non formal, can take place (Tisch, Laudemann, Kreß, & Metternich, 2017). A real production setup using real manufacturing machinery and control system are used to allow students practicing what they have learned through various projects within a learning environment (Veza et al., 2017).

The factory is characterized by its flexibility and changeability manufacturing environment to allow the students to address large variety of current and potential problem faced by the industry. This means that the processes and technologies available in the learning factory should be characterized by a changeable multilink value chains which enable a direct approach to different phases of product lifecycle process as a way to simulate a reality-conform production environment (Jäger A, Mayrhofer W, Kuhlang P, Matyas K, Sihn W, 2013).

The importance of Learning Factory in developing students competency

Past study indicated that the university curriculums and industrial practice are taking the assembly and assembly processes without proper educational and practical learning (Veza et al., 2017). A practice-based curriculum, which combines the hands-on experience aspects with the classroom lecture knowledge, is needed to balance the analytical and theoretical part of the knowledge transfer. One way to tackle this issue is by using the learning factory approach in the curriculum especially in the Technical and Vocational Education and Training (TVET).

Through the learning factory concept, a real factory characterized by its flexibility and changeability manufacturing environment could be brought into the university. Students were then allowed to independently solve complex problems by working together in a group and learned how to communicate well (Simons, Abé, & Neser, 2017). This way students can have the opportunity to develop their soft skills competencies such as teamwork and interpersonal communication skills, apart from the hands on experience and future job training. Furthermore, this experiential learning can leads to greater retention and application possibilities than traditional methods of classroom lectures (Cachay et al., 2012).

Challenges in the Education Curriculum

Even though graduates have been trained in the right technical knowledge, majority does not possess the soft skills required by the industry (N. A. Ismail, 2011). This is because the graduates maybe trained primarily in the right technical knowledge but not in the soft skills (Nazron, Lim, & Nga, 2017). In this globalization era, employees are expected to balance between their hard skills and soft skills (Syamsudin & Shiyu, 2018). This is because employability is enhanced by the right blend of soft skills, hard skills and personal attributes (Singh Dubey & Tiwari, 2020). Among the soft skills areas highly in demand are willingness to learn, teamwork/cooperation, self-control, organizational commitment, communication, leadership, decision making, problem solving skills, creativity, critical thinking, proactive, and self-confidence (Weber, Lee, & Crawford, 2020). Lacking of the soft skills among young graduates were found to be one the key factors that has affected the employability of Malaysian graduates and this skills gap issue need to be resolved. (Chan & Balaraman, 2019).

In addition, apart from soft skills, the students were also found to be lacked of practical experience on the application of the technical knowledge that they have learned (Nurkaliza Khalid et al. 2014). To produce skilled and competitive human capital, an excellence education and training system is needed in a country (M. T. Ismail & Daud, 2019). Therefore, universities need to play a big role in preparing the students that are ready for the job market.

METHODOLOGY

This research utilised a case study method to collect data from a public universities located in the state of Pahang, Malaysia. A qualitative research design has been used to explore the student's experience in using FIM learning factory. The interview data were collected from 56 undergraduates students who have used the FIM learning factory in their lean management class from 2018 until 2019. These participants were asked to respond to an open ended survey questions pertaining to their experience using the learning factory during the lean management class. An open ended survey question papers were given to the students at the end of the semester for them to give their appropriate responses.

Open coding was used to discover, and categorise the themes of the qualitative data which emerged from the analysis. Those theme were used to categories the variables voiced out by each respondent. The categories are bits of information from each interview that were grouped to explain the specific characteristics under each theme.

EMPIRICAL RESULTS

The outcome of this qualitative research study can be classified into eleven sub-themes. All these sub-themes are related to the objective of this reaseacher which is to analyse the experience of the undergraduate students in a Malaysian public university in using learning factory in their lean management class. The responses of all the participants have been summarized in Table 1

Table 1: Summary of the Participants Response

PARTICIPANTS NO.	FINDING ITEMS										
	A	B	C	D	E	F	G	H	I	J	K
1	1					1					
2			1			1					
3					1						
4	1										
5							1		1		
6		1					1				
7			1								
8	1			1							
9	1			1							
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11	1			1							
12	1										
13	1		1	1							
14	1										
15	1	1	1							1	
16			1	1	1						
17	1				1						
18	1										
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22	1	1									
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41	1										
42				1							
43		1									
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45		1	1								
46						1					
47				1							
48		1									
49		1		1							
50		1		1							
51		1									
52	1	1									
53		1	1								
54					1						
55		1									
56	1										
TOTAL	24	19	14	13	8	4	3	2	1	1	1

A Expose to real-life industry
B Improve student's understanding
C Gain practical experience
D Relate theory with practical experience
E Learn new knowledge
F Interesting learning experience

G Help to adapt to industrial life
H Improve problem solving skills
I Learn to manage work
J Boost confident level
K Improve student's analytical skills

The qualitative data obtained will be further discussed in this section. However, only seven out of the eleven themes will be discussed in detail.

Expose to real-life industry
According to the majority of the participants, the learning factory allow them to be expose to the real-life in the industry. This exposure is important since some of the students have never work in a factory before. It was mentioned by one of the participant:

"By using learning factory, I am exposed to the industry line distribution. As I have never work in a factory before, after entering learning factory only I know how the production line is working".

Participant no.1

Improve student's understanding
The activities involves in the learning factory have helped the students to understand the topics that have been informed during the class lecture. The following was mentioned by one of the participant:

"Using learning factory in Lean Management class is good because it help us more understand about lean management. This is because it can let us practise what we had learned and not only learned through the teaching slides only".

Participant no.29

Gain practical experience
Students claim that the activities in the learning factory enable them to tryout what they have learned in the classroom. The following statement was made by one of the participant:

"... we can see the situation in the factory. Also, we can learn a lot about practical things and we can feel the situation in the learning factory. At the same time, we can see clearly what we have learned from the theory".

Participant no.13

Relate theory with practical experience
Many subject areas in the higher education are theory-oriented learning goals. Eventhough there are some subject areas that are taught in both theory and practical, the numbers are very small particularly in the manufacturing or technology management. Even if they have, students are facing the problems in connecting between theory and practice (Eckerdal, 2015). Some young graduates are facing difficulties to convert theoretical knowledge into practical behavior in their career (Almodaires, 2009). However, feedback from the students who have used the learning factory in the lean management indicates that the activities in the learning factory have exposed them to the process of creating a product. The students claim that they were able to utilize the theoretical knowledge they have studied in class to solve the problem they faced. This was mentioned by the following statement:

"I think the use of learning factory is important to FIM students as they can be exposed about the process that happened when making a product. They can know about what happen before and after the product is made. They can also know many important feature of lean management and they can relate what they are doing with what they have studied".

Participant no.8

Learn new knowledge

Through learning factory activities, it gave the opportunity for students to explore new experiences. This was mentioned by the following participant.

" I learned something new which are identifying the variuos types of wastes in the factory. I also learned how to eliminate those wastes in the factory".

Participant no.10

Interesting learning experience

Developing motivated learners is a challenges faced by educators. Some students find learning as a boring and irrelevant matters. Thus, educators need to find the solutions to enhance student motivation by making the learning process as interesting and personally meaningful. One of the effective teaching method is to engage the student's cognitive and behavioral in their learning process (Vieluf & Göbel, 2019). The following statement was made by one of the participants in response to their experience in using the learning factory

"From my opinion, we as the students of Industrial technology really need to be exposed to this kind of teaching approach in the learning factory. By using this learning factory in the Lean Management class, we had experiencing something different from other classes before. It would be fun and interactive learning when it comes to practical learning since we usually get bored and sleepy if it just based on theoretical teaching".

Participant no.33

Help to adapt to industrial life

Today, business world is characterized by continual change and innovation. Workers need to acquire skills such as communication, problem solvers, team players, and lifelong learners to remain competitive at their workplace (Chan & Balaraman, 2019). In order to prepare students with those skills, educators need to create a relevent learning environments that can help students develop those much needed expertise. A problemcentered approach such as the learning factory can be used to help students develop those needed skills. This has been highlighted by one of the participants:

"In my opinion, learning factory enable the students to learned how to manage the work effectively and it can help the students to adjust themselves to the working life".

Participant no.5

CONCLUSION

From the analysis, it can conclude that the use of learning factory at the Faculty of Industrial Management, Universiti Malaysia Pahang has helped the students in various ways. Based on the responses by the participants, learning factory help get expose to real-life industry, improve student's understanding, gain practical experience, ability to relate theory with practical experience, learn new knowledge, interesting learning experience, and help to adapt to

industrial life. In addition, learning factory also improve their problem solving skills, help manage work, boost confident level and improve student's analytical skills.

The findings of this study are beneficial for universities and government bodies involved in the curriculum design to implement hands-on learning method. Future study on this area should work on analyzing more details how learning factory can be used to develop student's softskill that is much needed by the industry.

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